

CLAIMS

What is claimed is:

1. A protective apparatus for securing to a component (32) movable along a track (B) and for the monitoring of a protected zone (62; 82; 110) to be moved with the component (32), the protective apparatus comprising

a light transmitter (42; 64; 84) for the radiation of a divergent transmitted light beam (50, 50'; 76; 98) into a spatial zone containing the protected zone (62; 82; 110);

a light receiver (44; 64; 84) for the reception of at least some of the light of the transmitted light beam (50, 50'; 76; 98) of the light transmitter (42; 64; 84) radiated into the spatial zone and for the emitting of corresponding reception signals; and

a restriction device (52; 68; 102) which is arranged in the direction of a transmitted light path after a section of the transmitted light path which contains the protected zone (62; 82; 110) and by means of which the transmitted light beam (50, 50'; 76, 8) can be restricted to a less divergent received light beam (58; 80; 108) determining the width of the protected zone (62; 82; 110) in at least one direction.

2. A protective apparatus in accordance with claim 1, characterized in that an aperture angle of the transmitted light beam (50, 50'; 76; 98) is selected such that a width of the transmitted light beam (50, 50'; 86; 98) is larger by a factor of 10 in a pre-determined direction orthogonal to the transmitted light path directly in front of the restriction device (52; 68; 102) than a corresponding width of the received light beam (58; 80; 108) directly at the restriction device (52; 68; 102).

3. A protective apparatus in accordance with claim 1, characterized in that an aperture angle of the transmitted light beam (50; 50'; 76; 98) is selected such that a width of the transmitted light beam (50, 50'; 76; 98) directly at the restriction device (52; 68; 102) is larger in a pre-determined direction orthogonal to the transmitted light path directly in front of the restriction device (52; 68; 102) than a mean amplitude of movement of the transmitted light beam (50, 50'; 76; 98) to be expected directly at the restriction device (52; 68; 102) and caused by a relative movement of the light transmitter (42; 64; 84) and the restriction device (52; 68; 102).

4. A protective apparatus in accordance with claim 1, characterized in that the restriction device includes a diaphragm (52).

5. A protective apparatus in accordance with claim 1, characterized in that the restriction device includes a reflecting element (68) at which a part beam (78) of the divergent transmitted light beam (50, 50') to be supplied to the light receiver (44) can be reflected.

6. A protective apparatus in accordance with claim 1, characterized in that the restriction device (102) includes a retro-reflective element (104) at which a part beam (106) of the divergent transmitted light beam (98) to be supplied to the light receiver (84) can be reflected.

7. A protective apparatus in accordance with claim 5, characterized in that the light transmitter (64; 84) and the light receiver (64; 84) are arranged on the same side of the protected zone (82; 110).

8. A protective apparatus in accordance with claim 6, characterized in that the light transmitter (64; 84) and the light receiver (64; 84) are arranged on the same side of the protected zone (82; 110).

9. A protective apparatus in accordance with claim 5, characterized in that the light transmitter (64; 84) and the light receiver (64; 84) preferably have a common beam splitter (70) and at least one common transmission/reception lens (72; 88) arranged after the beam splitter (70) in the transmission direction.

10. A protective apparatus in accordance with claim 1, characterized in that the light receiver (44; 64; 84) has at least one reception element (100) whose reception area in a direction of divergence of the received light beam (58; 80; 108), which corresponds to the direction (B) in which the divergent transmitted light beam was restricted by the restriction device (52; 68; 102), has a larger extent than in a direction orthogonal thereto.

11. A protective apparatus in accordance with claim 1, characterized in that the light receiver (84) has a slit diaphragm (90) whose slit is arranged parallel to a direction of divergence of the received light beam (108) which corresponds to the direction in which the divergent transmitted light beam (98) can be restricted by the restriction device (102).

12. A protective apparatus in accordance with claim 1, characterized in that the light transmitted (84) is made such that a transmitted light beam (98) can be emitted by it which diverges differently in two directions orthogonal to one another.

13. A protective apparatus in accordance with claim 12, characterized in that the light transmitter (84) and the restriction device (102) are preferably made for the monitoring of a protected zone (110) which is areal in a direction orthogonal to a direction of movement of the component (32).

14 A protective apparatus in accordance with claim 1, characterized in that the light receiver (84) has a diaphragm (112) with a butterfly-like diaphragm aperture (114) which includes two wing regions (116) which are arranged transversely to the direction (B) in which the divergent transmitted light beam (98) can be restricted by the restriction device (102).

15. A protective apparatus in accordance with claim 5, characterized in that the restriction device (102) includes at least two reflecting or retro-reflective elements (104) which represent an encoding.

16. A protective apparatus in accordance with claim 15, characterized in that the reflecting or retro-reflective elements (104) are preferably inclined with respect to one another such that a drop in an intensity of the transmitted light beam (98) or of the received light beam (98; 108) can substantially be compensated in the direction of a margin of the light beam.

17. A protective apparatus in accordance with claim 1, characterized in that the light receiver (44; 64; 84) has a linear arrangement of photo-detection elements (100).

18. A protective apparatus in accordance with claim 1, characterized by an evaluation circuit (57; 96) for the reception of received signals of the light receiver (44; 64; 84) and for the emitting of corresponding monitoring signals.

19. A component for an apparatus which can be moved on a pre-determined track (B) by a drive device of the apparatus, characterized in that a protective apparatus in accordance with any one of the preceding claims is held at the component (32), with the protected zone (62; 82; 110) including at least some of the track (B).

20. A component in accordance with claim 18, characterized in that the light transmitter (42; 64; 84) and the restriction device (52; 68; 102) are held at the component (32) at two holding arms (38, 40) spaced apart spatially transversely to the track (B) of the component (32).

21. A shaping apparatus, in particular a bending press, comprising a component in accordance with claim 18 made as a shaping tool, in particular as a bending tool.

22. A shaping apparatus, in particular a bending press, comprising a component in accordance with claim 19 made as a shaping tool, in particular as a bending tool.

23. A method for the monitoring of a protected zone (62; 82; 110) which has to be moved along with a component (32) moved along a track (B), in which

a divergent transmitted light beam (50, 50'; 76; 98) is transmitted and moved along with the component (32);

the divergent transmitted light beam (50, 50'; 76; 98) is restricted, after covering a light path including the protected zone (62; 82; 110), to a less divergent received light beam (58; 80; 108) moved along with the component (32) and defining the width of the protected zone (62; 82; 110) in at least one direction; and

the received light beam (58; 80; 108) is received and monitored

24. A method in accordance with claim 23, characterized in that a reflecting element (68) is used for the restriction of the transmitted light beam (50, 50'; 76; 98).

25. A method in accordance with claim 23, characterized in that a retro-reflective element (104) is used for the restriction of the transmitted light beam (50, 50'; 76; 98).